Comment [on ”Origin of the Chichibu Sea, Japan: Middle Paleozoic to Early Mesozoic plate construction in the northern margin of the Gondwana continent” by S. Otoh, S. Yamakita, and S. Yanai]

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COMMENT ON "ORIGIN OF THE CHICHIBU SEA,JAPAN: MIDDLE PALEOZOIC TO EARLY MESOZOIC PLATE CONSTRUCTION IN THE NORTHERN MARGIN OF THE GONDWANA CONTINENT" BY S. OTOH, S.YAMAKITA, AND S. YANAI

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INTRODUCTION

In a recently published paper dealing with the Late Paleozoic-Triassic geohistory of SW Japan, Otoh et al. [1990] deny the existence of a Permian-Triassic orogeny. Nevertheless, this event has been studied in many places and for a long time, from the petrologic, stratigraphic, structural, geochronologic and geodynamic points of view. It has been called the Akiyoshi orogeny in Japan and, in a more general sense, the Indosinian orogeny in eastern Asia [e.g., Kobayashi, 1941, 1978; Kimura, 1974; Tanaka and Nozawa, 1977; Maruyama and Seno, 1986; Caridroit et al., 1987; Faure and Charvet, 1987; Faure et al., 1988; Charvet et al. 1990]. The Akiyoshi orogeny is recognized from central Japan up to the South Ryukyu islands for more than 2500 km. The deformation structures related to the Akiyoshi orogeny are best preserved in the Inner part of SW Japan (i.e., on the Sea of Japan side). They are sealed by Late Triassic continental or shallow water deposits which rework Permian sedimentary and metamorphic rocks.

Before the flaws of the proposed geodynamic model are discussed, some wrong statements have to be corrected.

1. Although not directly concerned with the topic of the paper, the assertion that the high pressure Sanbagawa metamorphism is post-Aptian is incorrect. Radiometric data obtained by the $^{39}Ar/^{40}Ar$ method indicate older ages, around 130 Ma, i.e., Berriasian-Valanginian [Monié et al., 1988; Takasu and Dallmeyer, 1990].

2. More important is the description of the geological zonation. In particular, the so-called "Chizu Belt" does not exist. The four arguments given by the authors in favor of the existence of this belt are groundless. Chaotic occurrence of Permian and Triassic chert is not a characteristic feature of the "Chizu belt." A similar occurrence is also observed in the upper part of the Tanba zone and in the Ultra-Tanba zone [Caridroit et al., 1985]. In the same way, olistoliths of metamorphic and ultramafic rocks are said to be found in the "Chizu belt" but not in the Tanba belt. Such an observation is not surprising, since the only possible source area for these rocks lies in the pre-Tertiary units located on the Sea of Japan side of SW Japan: i.e., Sangun schists, Yakuno ophiolite, eventually Hida belt. There is obviously a facies change into the Tanba basin; the northern area or so-called "Chizu Belt" is richer in chaotic blocks than the southern area, because it is closer to the source area. The last two arguments developed by Otoh et al. are meaningless: "the Chizu belt is not a window because it is a thrust sheet" (p. 427)! Such an assertion given without any detailed map, nor cross section, is unconvincing. Moreover, the map (Figure 1) suggests that the western part of the "Chizu belt" extends into the Mino-Tanba belt. Previous detailed field works [e.g., Hayasaka 1987; Caridroit et al. 1985, 1987; Faure et al. 1986] have shown that the so-called "Chizu belt" corresponds to tectonic windows of the Mino-Tanba belt. The geology of SW Japan is complex enough without adding to the confusion by replacing a rather well defined zone like the Tanba zone by approximately defined ones which do not bring any new insight on the geological understanding.

3. It is incorrect to include the Yakuno complex in the Maizuru belt, because the Yakuno complex is made of ophiolitic rocks of Carboniferous to Permian age, while the Maizuru belt is formed by Permian detrital rocks with various olistoliths, some of them derived from the Yakuno ophiolite. When dealing with the Permian-Triassic orogeny, even to try to demonstrate its nonexistence, it is impossible to place the Yakuno ophiolitic nappe and its tectonic substratum into the same Maizuru belt.

4. In the same way, the Ultra-Tanba zone, though imperfectly dated by radiolaria, is composed of rocks more similar to the Jurassic Tanba zone than to the Maizuru belt. According to the genuine definition of the Ultra-Tanba zone [Caridroit et al., 1985], it consists from bottom to top of Middle to Late Permian chert overlain without unconformity by a Mesozoic flysch and olistostrome. In addition, Otoh et al. use the definition of the Ultra-Tanba zone of Ishiga [1986] which is significantly different from the initial definition of Caridroit et al. [1985]. As a matter of fact, Ishiga [1986] includes in the Ultra-Tanba zone a "greenish sandstone" formation assumed to be Permian in age because badly preserved radiolaria are found in chert pebbles in the greenish sandstone formation. Of course, some pelitic elements are Permian in age, like some of the olistoliths found in the Tanba belt, since they are coming from the Paleozoic belt, but the main part of the greenish sandstone formation is still Jurassic and belongs to the unit 2 of the Tanba belt.

5. The argument that the Permian-Carboniferous basic rocks of the Outer belt were formed near land because "interpillow arkose sandstone was reported from a basaltic pillow" (p. 429) is questionable, as it

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is based on one observation only. Indeed, the common facies of the interpillow sediments in Shikoku are pelagic limestone, red shale, and chert [Suyari et al., 1982], which suggest a deep sea origin for the basic rocks. The exceptional occurrence of the arkosic sediment can be explained by remembering that these basic rocks are olistoliths enclosed into a Jurassic matrix that can be locally very coarse grain sandstone.

6. Finally, it is said that the Jurassic sediments in the Outer zone of SW Japan (i.e., south of the fault of the Median Tectonic Line, on the Pacific side) "are dominated in reef limestone" (p.430). This assertion is wrong. Indeed, the Jurassic reef limestones, also called the Torinosu facies, are meter-to-decameter scale olistoliths included into a Late Jurassic-Early Cretaceous mudstone-sandstone matrix. The deposition place of the limestone is uncertain, although it is probably rather meridional. The Jurassic reef facies of SW Japan cannot be opposed to the Jurassic shallow water sediments covering the Inner belt since they are not in situ rocks. Moreover, the Sanbosan zone is not correctly presented, since all the Carboniferous to Triassic limestone and the basic volcanics are olistoliths.

More generally, Otoh et al. introduce a confusion on the Carboniferous-Permian limestones and basic rocks of the Outer belt. They are alternatively interpreted as belonging to the Kurosegawa belt or to the Tanba-Mino belt. In fact, they are large slabs or olistoliths enclosed in a Jurassic olistostrome [e.g., Yokoyama et al., 1979; Tominaga and Hara, 1980; Suyari et al., 1982; Faure et al., 1986]. The largest blocks are found in the Onogahara, Torigatayama, Tosayama, and Sawadani areas. The olistostrome is quite different from the neritic rocks overlying the Kurosegawa belt. In the present state of knowledge, the limestone-basic rocks are in fault contact with the Kurosegawa belt and there is no evidence at all for considering that the olistoliths are coming from the south. Therefore it is not right to place the Permian-Carboniferous rocks in the Kurosegawa belt. Because it has been acknowledged for a long time by many workers, including Otoh et al., that the Middle to Late Permian faunas of the Outer belt, in the olistoliths, are similar to those of the Inner belt, and because all the tectonic data indicate a southward vergence for the structures in the Outer belt, we favor the following hypothesis. The Permian-Carboniferous rocks were part of the Inner belt, but fell, as slump deposits and olistoliths, into the Tanba basin, and they were afterwards tectonically transported as a nappe, called the Superficial nappe [Faure et al., 1986] onto the Outer belt. Presently, this nappe forms a part of the Chichibu belt of the Japanese geologists. But we have shown that the Chichibu belt is geologically meaningless [Faure et al. 1986].

DISCUSSION OF THE GEODYNAMIC MODEL

The geodynamic model proposed by Otoh et al. is very superficial. It is totally irrealistic to ignore deep seated phenomena when dealing with plate tectonics. Presently, the Yakuno ophiolite is thrust upon the Maizuru group, and both units are unconformably covered by undeformed Upper Triassic sandstone and conglomerate. Neither the origin of the granulite facies metamorphism experienced by theYakuno ophiolite nor the emplacement mechanisms are discussed. From Figure 4 of Otoh et al., one gets the impression that the Yakuno ophiolite is "in situ," which is certainly unacceptable as the Permian obduction is demonstrated.

According to Otoh et al., the Silurian-Devonian rocks of the Hida-Hida marginal and Kurosegawa belts were deposited in the northern continental margin of Gondwana. However, according to Hiroi [1981] and Cluzel [1990a], the Hida and Hida marginal belts are closely related to the Ogcheon belt of Korea, where there is no evidence of south verging subduction. The Silurian-Devonian rocks of Japan are likely to belong to the southern margin of the South China-Korea block rather than the northern margin of Gondwana.

Because of its present width of a few kilometers, it is impossible to determine the vergence of the subduction below the Kurosegawa belt responsible for the Middle-Late Permian acidic tuff. There is absolutely no evidence for a southward dipping subduction zone below the Kurosegawa belt; on the other hand, a northward dipping subduction is perfectly acceptable.

The Otoh et al. model assumes that in Late Permian-early Triassic times, the northward subduction zone below the Hida zone stopped. From a mechanical point of view, there is no reason for this subduction to stop, since more than 1000 km of oceanic crust would still exist at that time south of the Hida zone. More likely, the Permian subduction should have continued, perhaps with a different rate or direction, until all the oceanic crust was consumed and a meridional continental mass came in contact with the northern one. It is worth to note that everywhere in eastern Asia, the Late Permian-Early Triassic period corresponds to the climax of the Indosinian orogeny. The ductile deformation and high pressure-low temperature metamorphism observed into the Sangun schists are sealed by the deposition of Upper Triassic molasse like coarse sediments which unconformably cover the Indosinian nappes.

The model presented in the discussed paper is unable to account for numerous geological data such as (1) the emplacement of the Yakuno ophiolite, (2) the origin, deformation, and uplift of the high-pressure Sangun schists, (3) the Late Permian-Early Triassic deformations observed in Korea [Cluzel, 1990b] and (4) the syntectonic granitic magmatism and coeval high-temperature metamorphism also known in South Korea [e.g., Cliff et al., 1985]. All these main features of the Indosinian orogeny of the Japan-Korea area are better explained by a continental subduction model such as that already proposed by Caridroit et al. [1986] or Faure and Charvet [1987]. When Otoh et al. complain that their model is "not adequately constrained by kinematic analyses" (p.

437), they should take a closer look at the already available microtectonic data.

Indeed, the geology of Japan is very complex, and none of the published geodynamic models is able to account for all of the geological features. But the model presented by Otoh and his colleagues appears very unlikely, since it deliberately ignores the already established facts supporting the existence of Permian-early Triassic tectonometamorphic events.

REFERENCES

Caridroit, M., K. Ichikawa, and J. Charvet, The Ultra-Tanba zone, A new unit in the Inner Zone of southwest Japan, *Chikyu Kagaku Chigaku Dantai Kengakai, 39*, 210-219, 1985.

Caridroit, M , M Faure and J. Charvet, Nouvelles données stratigraphiques et structurales sur le Paléozoique supérieur des zones internes du Japon sud-ouest, Un essai sur l'orogenèse permienne, *Bull. Soc. Géol. Fr., 3*, 683-691, 1987.

Charvet, J., M. Faure, O. Fabbri, D. Cluzel, and H. Lapierre, Accretion and collision during east-asiatic margin buiding. A new insight on the peri-Pacific orogenies, in *Terrane Analysis of China and the Pacific Rim, Earth Sci. Ser.* vol 13 edited by T.J. Wiley, D.G. Howell, and F.L Wong, pp.161-191, Circum-Pacific Science Council for Energy and Mineral Resources, Houston Tex., 1990.

Cliff, R.A., G. Jones, W.C Choi, and T.J. Lee, Strontium isotopic equilibration during metamorphism of tillites from the Ogcheon Belt, South Korea, *Contrib. Mineral Petrol , 90*, 346-352, 1985

Cluzel, D., Geodynamics of the Ogcheon Belt (South Korea), *Tectonophysics, 183*, 41-56, 1990a.

Cluzel, D., Tectonique synsédimentaire et lacune du Carbonifère supérieur en Corée du Sud, Comparaison avec le domaine paléozoique du Japon sud-ouest et implications géodynamiques pour la marge est-asiatique, *C R. Acad. Sci. Paris, Ser. 2, 311*, 189-195, 1990b.

Faure, M., and J., Charvet, Late Permian/early Triassic orogeny in Japan: Piling up of nappes, transverse lineation and continental subduction of the Honshu block, *Earth Planet. Sci. Lett., 84*, 295-308, 1987

Faure, M., M. Caridroit, and J. Charvet, The Late Jurassic oblique collisional orogen of SW Japan: New structural data and synthesis, *Tectonics, 5*, 1089-1114, 1986.

Faure, M., P. Monié, and O. Fabbri, Microtectonic and ^{39}Ar-^{40}Ar dating of high pressure metamorphic rocks of the South Ryukyu Arc and their bearings on the pre-Eocene geodynamic evolution of eastern Asia, *Tectonophysics, 156*, 133-143, 1988.

Hayasaka, Y., Study on the late Paleozoic-early Mesozoic tectonic development of western half of the Inner Zone of southwest Japan, *Hiroshima Daigaku Chigaku Kenkyu Hokoku, 27*, 119-204, 1987.

Hiroi, Y., Subdivision of the Hida metamorphic complex, central Japan, and its bearing on the geology of the Far-East in pre-Sea of Japan time, *Tectonophysics, 76*, 317-333, 1981.

Ishiga, H., Ultra-Tanba zone of SW Japan, *J. Geosci., Osaka City Univ., 29*, 45-88, 1986.

Kimura, T., The ancient continental margin of Japan in *The Geology of Continental Margins*, edited by C.A. Burk and C.L. Drake, pp. 817-829, Springer-Verlag, New-York, 1974

Kobayashi, T., The Sakawa orogenic cycle and its bearing on the origin of the Japanese islands, *J. Fac. Sci. Imp. Univ. Tokyo, Sect. 2, 5*, 219-578, 1941.

Kobayashi, T., The Triassic orogeny in Japan and southeast Asia, *Proc. Jpn. Acad , 54*, 510-515, 1978.

Maruyama, S., and T. Seno, Orogeny and relative plate motions: Example of the Japanese islands, *Tectonophysics, 127*, 305-324, 1986.

Monié, P., M. Faure, and H. Maluski, Premières datations $^{39}Ar/^{40}Ar$ du métamorphisme haute pression de Sanbagawa (Japon SW), *C. R. Acad. Sci. Paris, Ser. 2, 304*, 1221-1224, 1988.

Otoh, S., S Yamakita, and S Yanai, Origin of the Chichibu sea, Japan: Middle Paleozoic to early Mesozoic plate construction in the northern margin of the Gondwana continent, *Tectonics, 9*, 423-440, 1990.

Suyari, K , Y. Kuwano, and K. Ishida, Stratigraphic and geological structure of the Mikabu Greenrock Terrain and its environs, *J. Sci. Univ Tokushima 15*, 51-71, 1982

Takasu, A., and R.D. Dallmeyer, $^{40}Ar/^{39}Ar$ mineral age constraints for the tectonothermal evolution of the Sanbagawa metamorphic belt, central Shikoku, Japan: A Cretaceous accretionnary prism, *Tectonophysics, 185*, 111-139, 1990.

Tanaka, K., and T. Nozawa, *Geology and Mineral Resources of Japan*, 430 pp., Geological Survey of Japan, Tokyo, 1977.

Tominaga, R , and I. Hara, Geologic structure of the Chichibu belt in the Ohnogahara area, western Shikoku, *Stud Late Mesozoic Tect. Jpn., 2*, 43-47, 1980.

Yokoyama, T., R. Tominaga, I. Hara, and Y. Kuwano, Geologic structure of the Sawadani area on the north of the Kurosegawa Terrane, Tokushima Prefecture, *Stud Late Mesozoic Tect Jpn., 1*, 9-22, 1979.

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